



Armed Forces College of Medicine AFCM



Thymus -1

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Professor of Histology

INTENDED LEARNING OBJECTIVES (ILO)



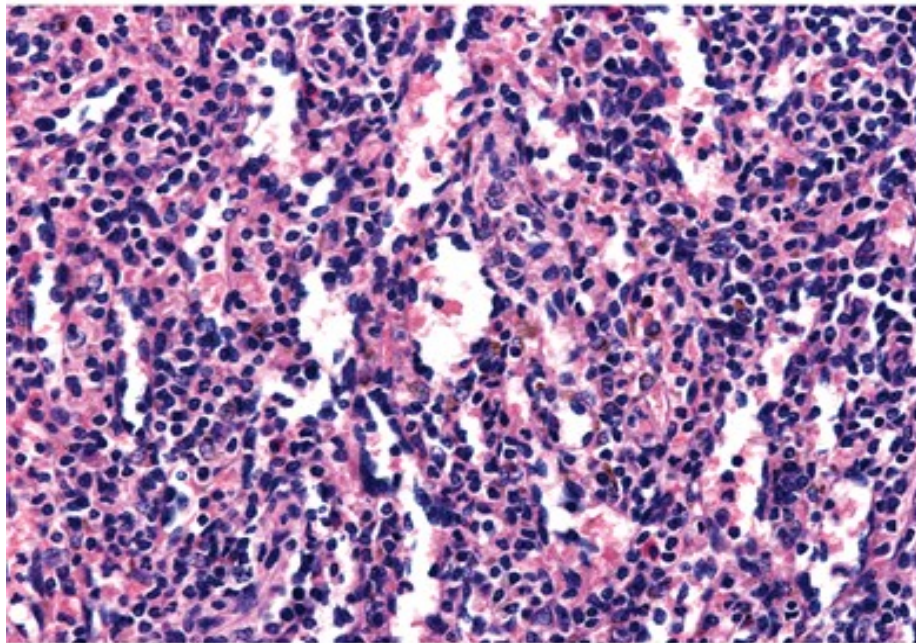
- **By the end of this lecture you should be able to:**
 - 1. Describe the microscopic structure of the spleen (red pulp and marginal zone).**
 - 2. Correlate the structure of the spleen to the **function**.**
 - 3. Describe the microscopic structure of the thymus (**cortex of the thymus**).**
 - 4. Correlate the structure of the thymus to the **function**.**

The Spleen

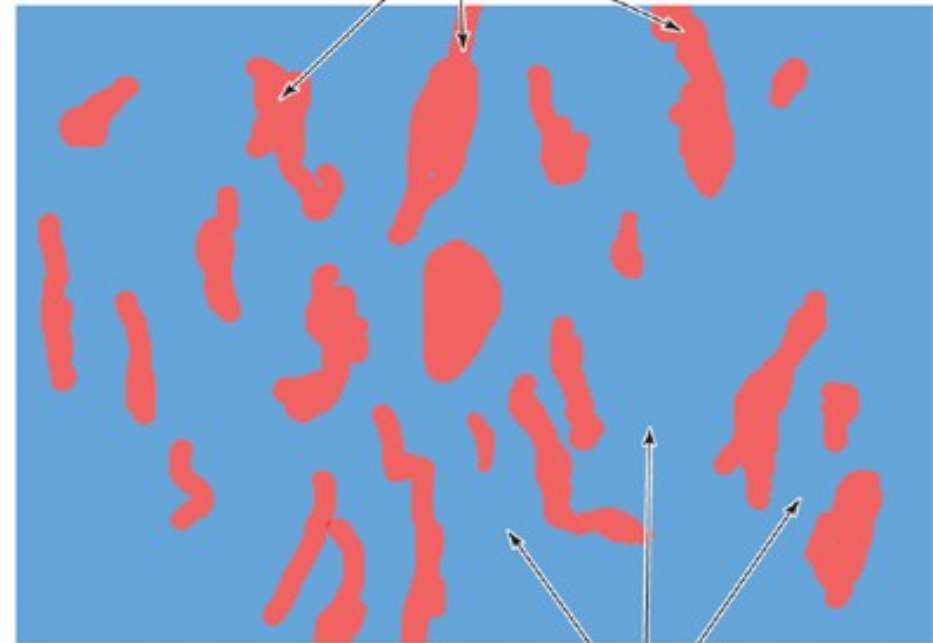


2-The red pulp: Splenic sinusoids Splenic cords

Splenic sinusoids



A



B

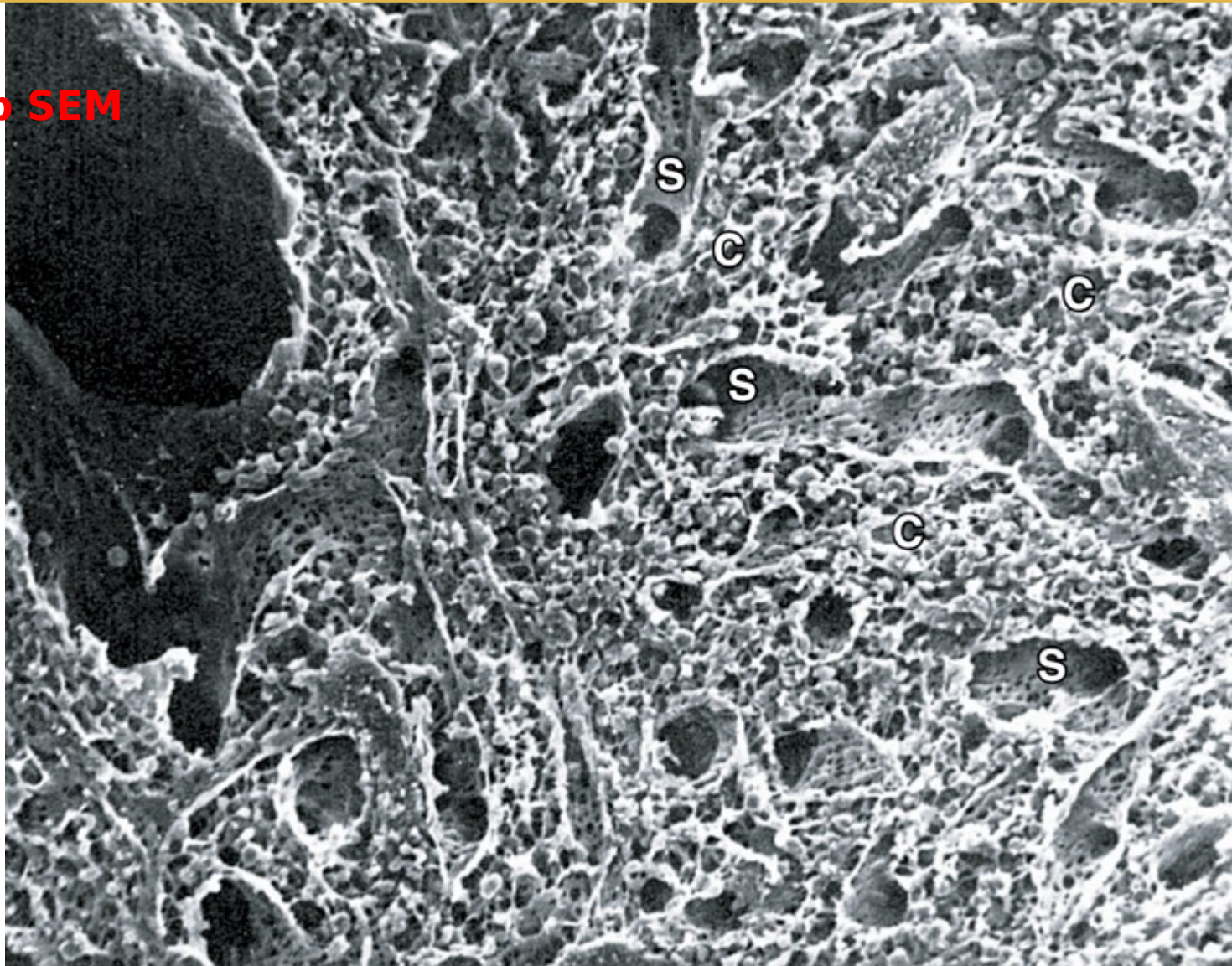
Splenic cords

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The Spleen



Red Pulp SEM

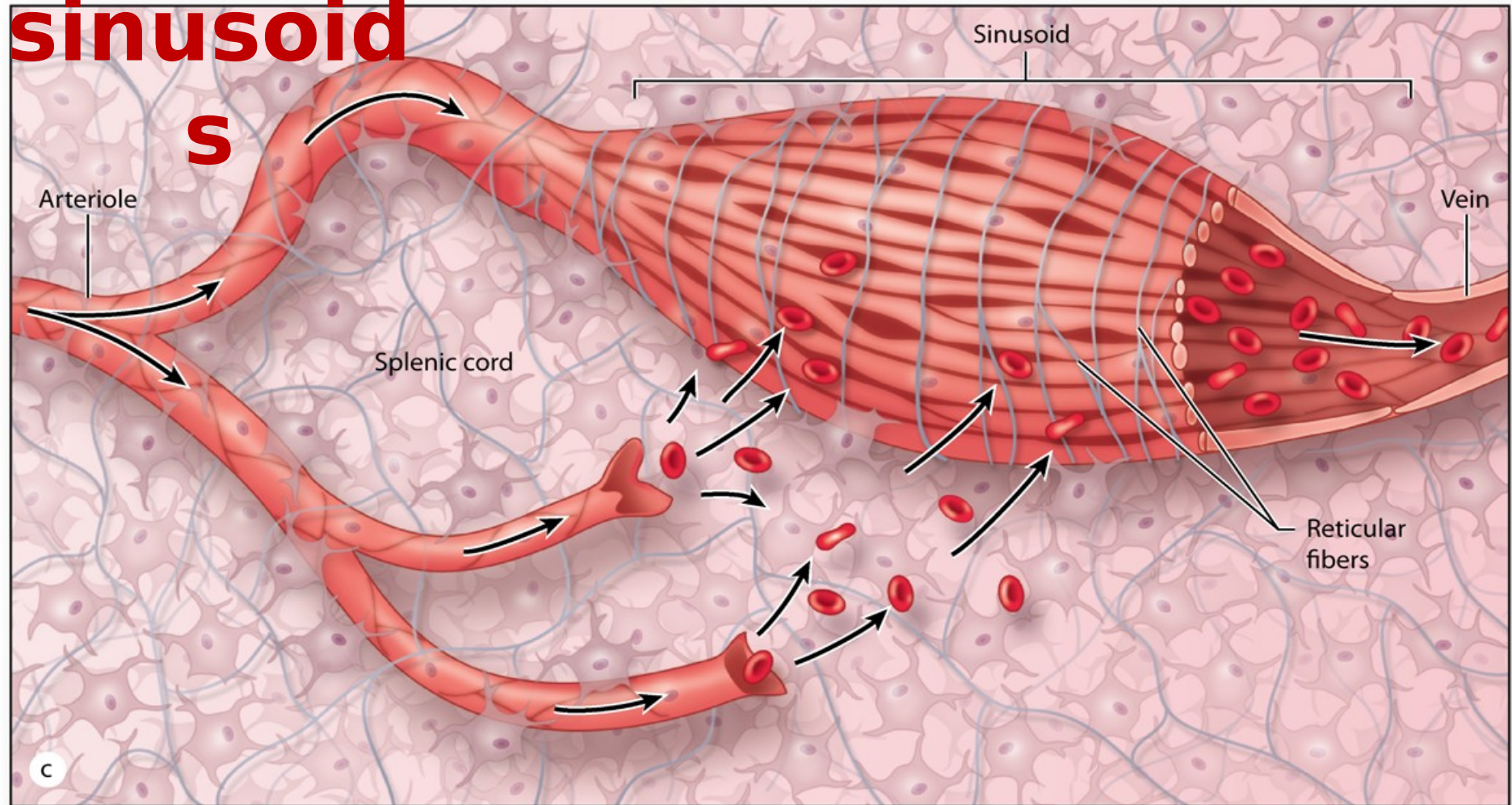


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The Spleen



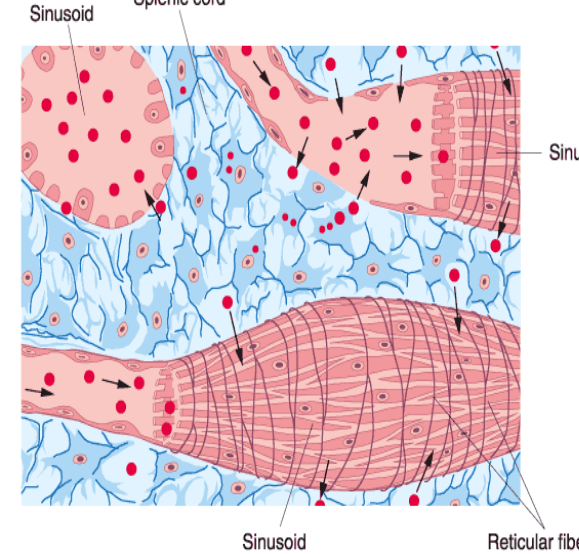
Splenic sinusoid



The Spleen

Splenic sinusoids

- **Fusiform in shape and wide**
- **Lined by long fusiform endothelial cells.**
- **Wide slit like spaces between the adjoining cells which allow the exchange of fluid and movement of cells between the sinusoids and cords.**
- **Sinusoids are supported by reticular fibers which are arranged perpendicular to the long axis of the**

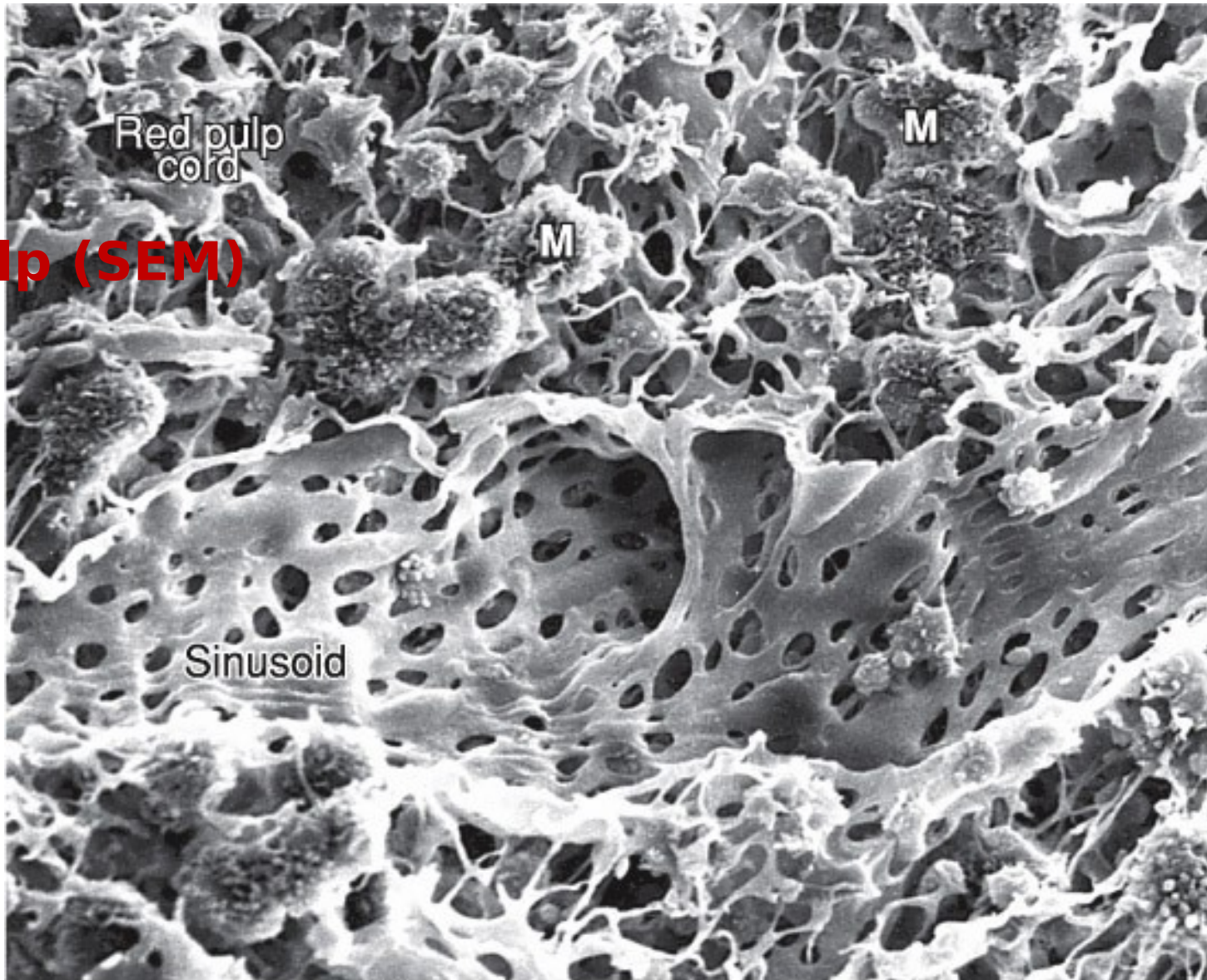


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The Spleen



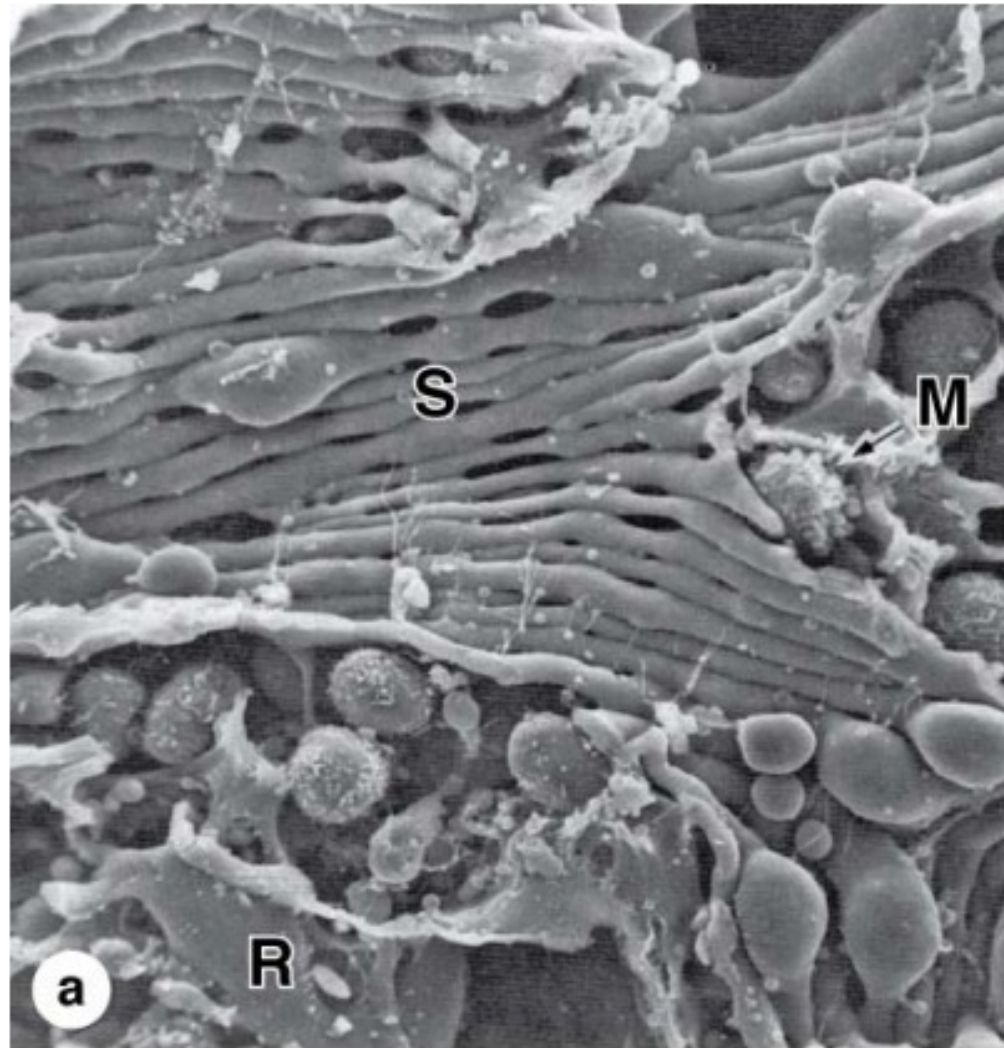
Red pulp (SEM)



The Spleen



Splenic sinusoid s



Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas*, 12th Edition: <http://www.accessmedicine.com>
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The Spleen



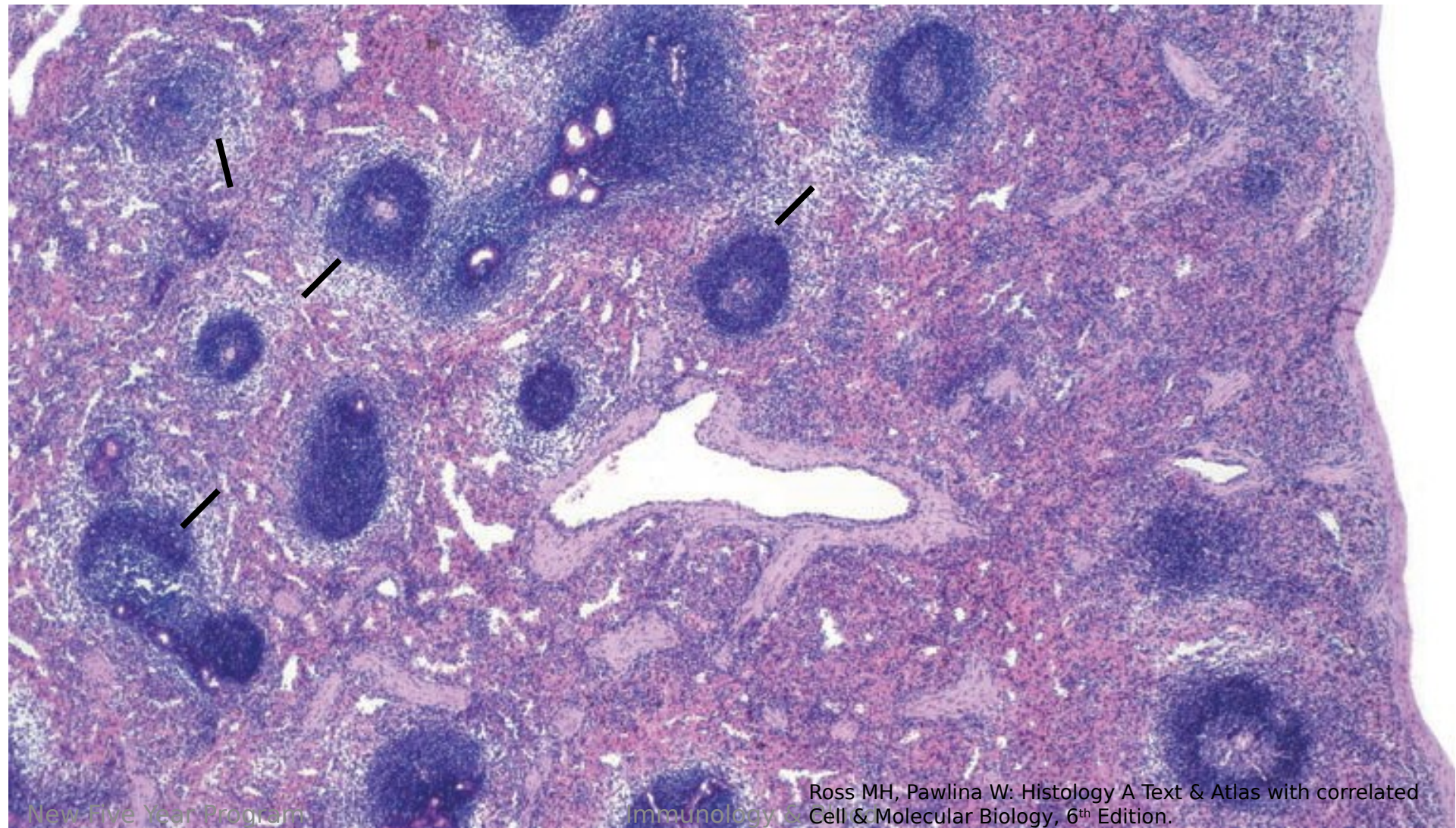
Splenic cords (Cords of Billroth)

- **It is the tissue in-between the blood sinusoids.**
- **The cords consist of a network of reticular cells and fibers containing:**
 - **All elements of blood (RBCs & WBCs)**
 - **Lymphocytes**
 - **Macrophages**
 - **Plasma cells**
 - **Dendritic cells**

The Spleen



The marginal zone-3



The Spleen



The marginal zone

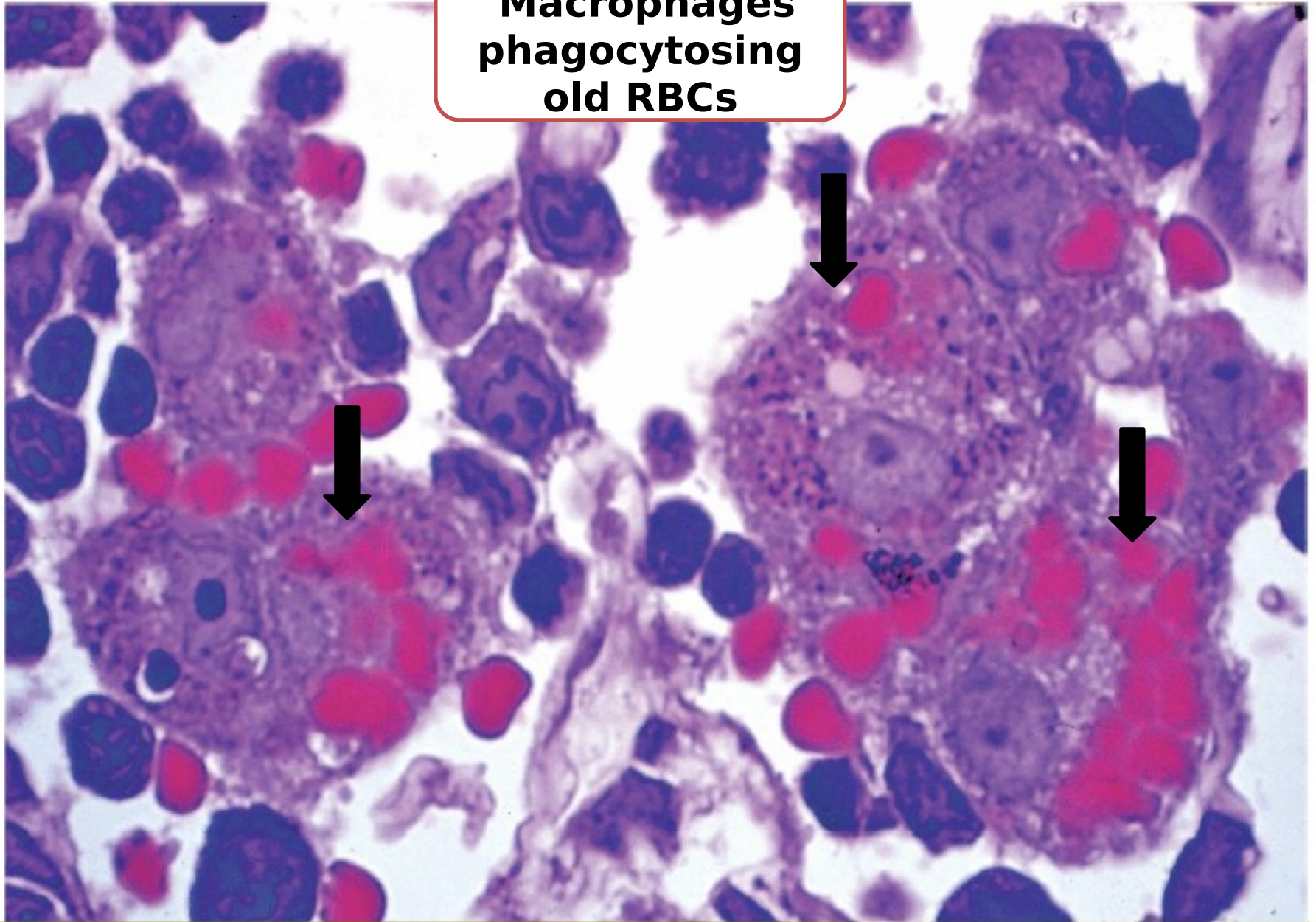
- The **border** between the white and red pulps.
- Composed of many **B** and **T** lymphocytes, **macrophages**, **plasma** cells and **dendritic** cells.
- Numerous wide blood sinuses called **Marginal sinuses**.
- Importance: Circulating **T** and **B** **lymphocytes leave** the blood to enter to the white pulp.

Functions of the spleen



- **Filtration of blood**
- **Storage of blood**
- **Removal of old worn out RBCs by macrophages and recycling of iron in the body**
- **Immunological response (B and T lymphocytes)**
- **Hemopoietic organ in fetal life**

**Macrophages
phagocytosing
old RBCs**



The spleen



Clinical correlation-Splenectomy

- In cases of **traumatic rupture of spleen** → loss of blood in abdominal cavity → life-threatening condition → surgical removal of spleen = splenectomy.
- Immunological functions of the spleen are carried out by **other lymphoid organs**
- Hematological functions occur in **liver and bone marrow.**

Match (Activity)

B	A
Billroth cords	Splenic sinusoids
Numerous T lymphocytes	Splenic cords
Lymphocytes exit blood	Splenic Capsule
Germinal center	Marginal sinus
Reticular fibers perpendicular	Peri-arterial lymphatic sheath

The diagram illustrates the matching process between two columns of anatomical terms. Blue arrows indicate correct matches, while red arrows indicate incorrect matches.

- Correct matches (Blue arrows):**
 - Numerous T lymphocytes → Splenic cords
 - Lymphocytes exit blood → Splenic Capsule
 - Reticular fibers perpendicular → Peri-arterial lymphatic sheath
- Incorrect matches (Red arrows):**
 - Billroth cords → Splenic sinusoids
 - Germinal center → Marginal sinus

Question



• **The splenic blood sinusoids are characterized by which of the following?**

- 1. Are lined by circularly arranged endothelial cells.**
- 2. Are found in marginal zone.**
- 3. Supported by collagen fibers type I.**
- 4. Are associated with macrophages**

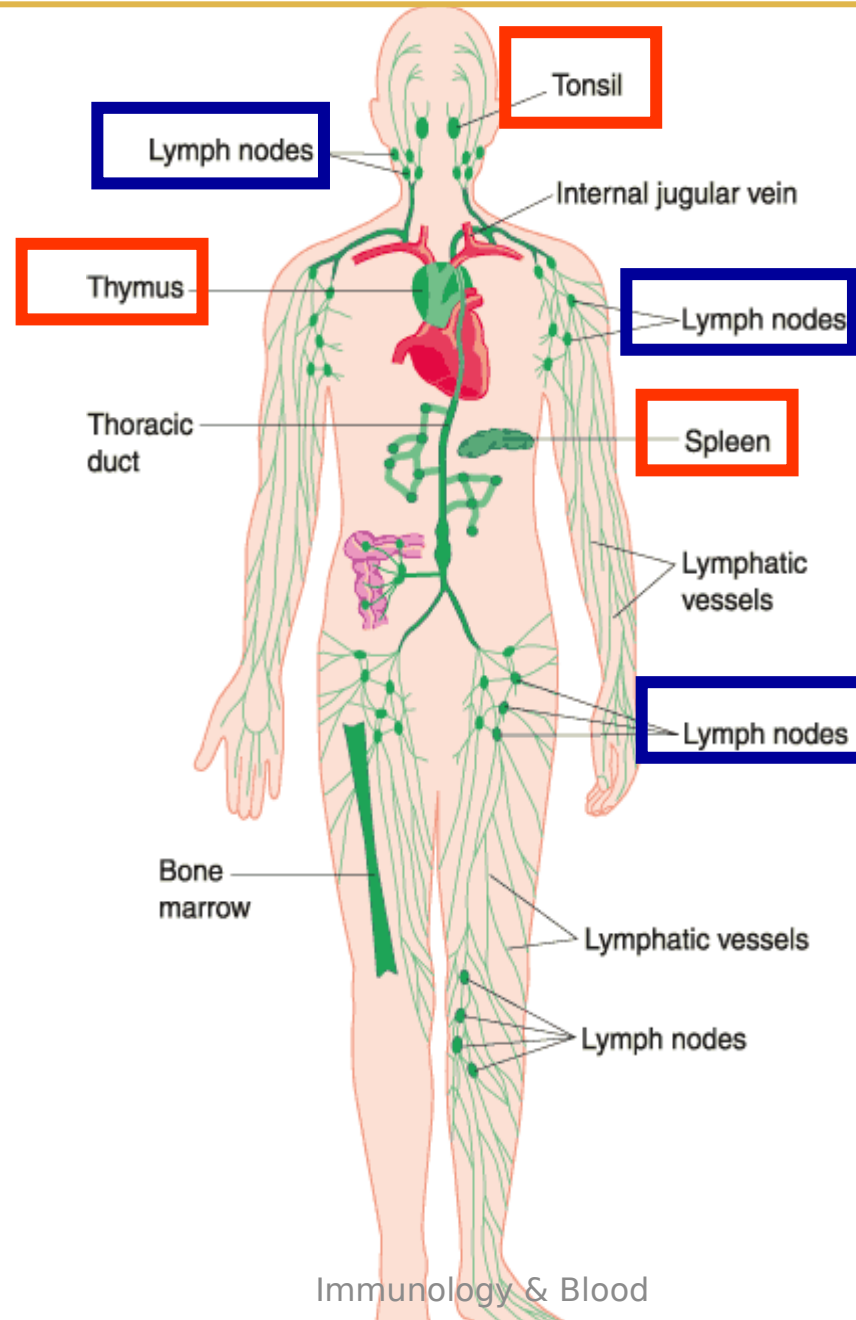
Question



- **The thymus dependent zone of the spleen is present in:**

- 1. Peripheral white pulp.**
- 2. Peri-arterial lymphatic sheath.**
- 3. Marginal zone.**
- 4. Billroth cords.**

The Lymphatic System



LYMPHOID TISSUE



```
graph TD; A[LYMPHOID TISSUE] --> B[I. capsulated]; A --> C[II. Non Capsulated]; B --> D[Thymus]; B --> E[Lymph node]; E --> F[Spleen]; C --> G[Solitary]; C --> H[Aggregated];
```

The diagram is a hierarchical flowchart. At the top is a purple box labeled 'LYMPHOID TISSUE'. An orange line connects it to two boxes below: 'I. capsulated' (orange) on the left and 'II. Non Capsulated' (light grey) on the right. From 'I. capsulated', a blue line leads to 'Thymus' (red), which then leads to 'Lymph node' (red), which finally leads to 'Spleen' (red). From 'II. Non Capsulated', a blue line leads to two boxes: 'Solitary' (light grey) and 'Aggregated' (light grey).

I. capsulated

Thymus

Lymph
node

Spleen

II. Non Capsulated

Solitary

Aggregated

The Thymus



- **Bilobed organ.**
- **Large early in life and involutes near the age of puberty.**
- **Is the primary or central lymphoid organ for → T cell education.**
- **Derived from**
 - **- Endoderm (epithelial reticular cells)**
 - **- Mesoderm (lymphocyte)**

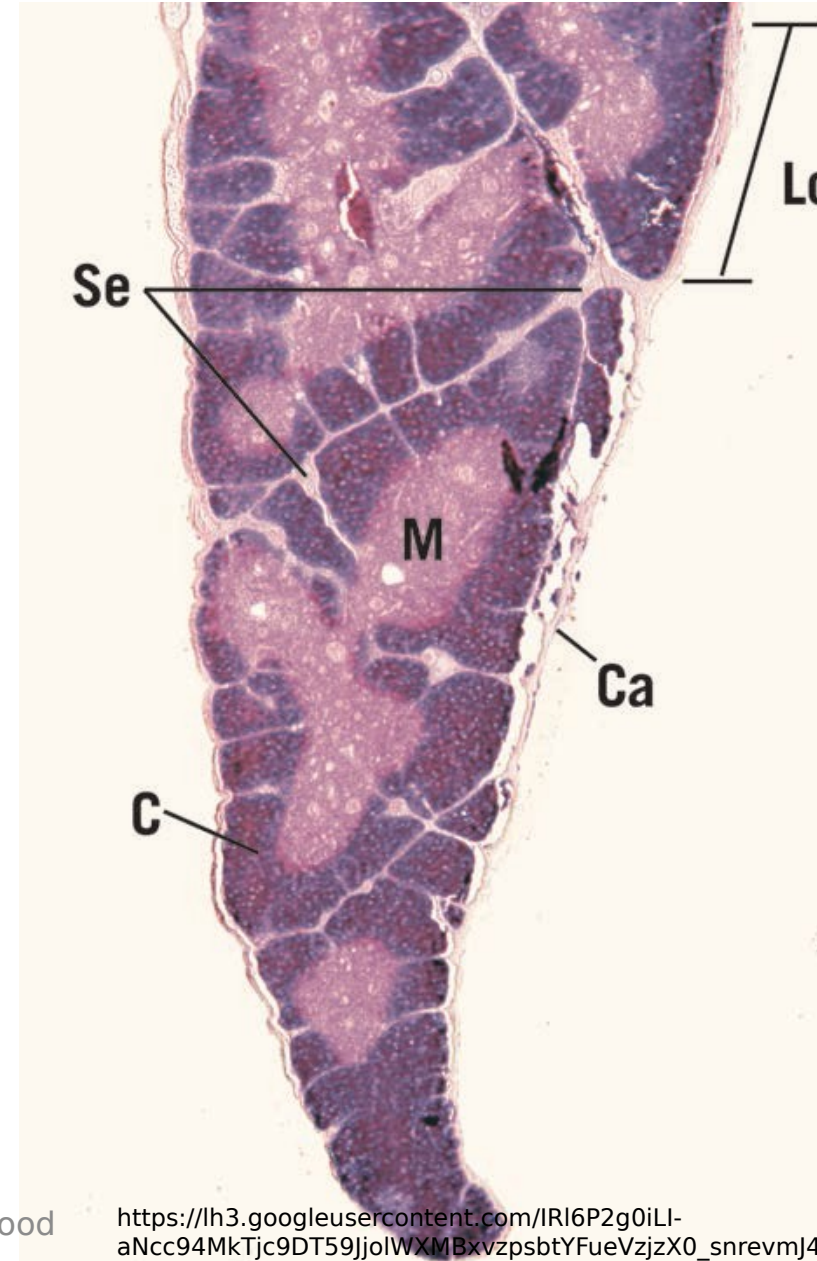


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The Thymus



- Stroma
- Parenchyma



The Thymus



■ Stroma

1. **Capsule: thin**

2. **Trabeculae:** divide parenchyma into **incomplete lobules** so that there is continuity between the cortex & medulla of adjacent lobules.

■ **The reticular stroma that support the parenchyma of the thymus is formed by Epithelial-Reticular Cells (ERCs)**

CYTORETICULUM



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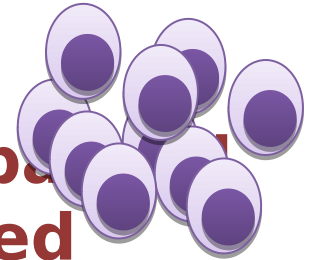
The Thymus



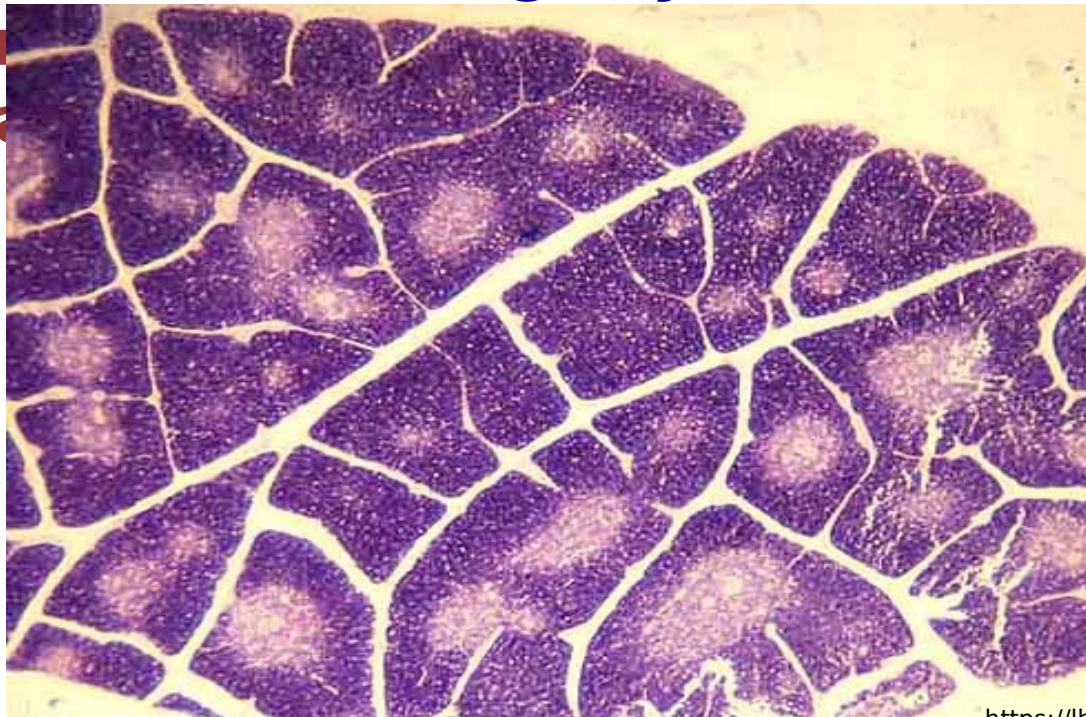
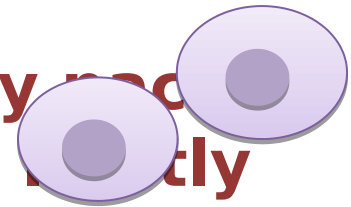
- ❑ Parenchyma

- ❑ Each lobule is formed of:

1. Cortex → darkly stained → closely packed small T lymphocytes with darkly stained nuclei.



2. Medulla → lightly stained → loosely packed with large, pale-stained cells.



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Blood vessels

Medulla

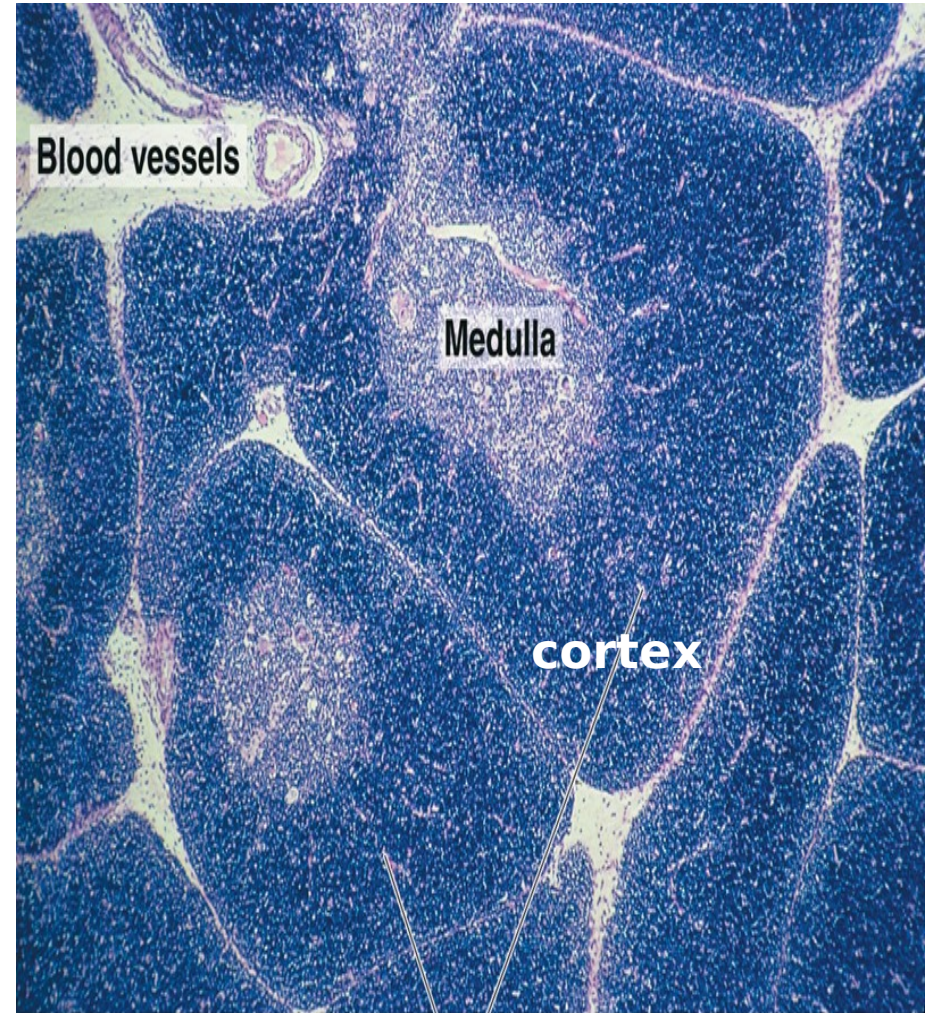
Cortex

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The Cortex of the Thymus



- It is the outer dark region of the lobule.
- Site of maturation of T-lymphocytes.
- Contains:
 - T
 - Lymphoblasts
 - T



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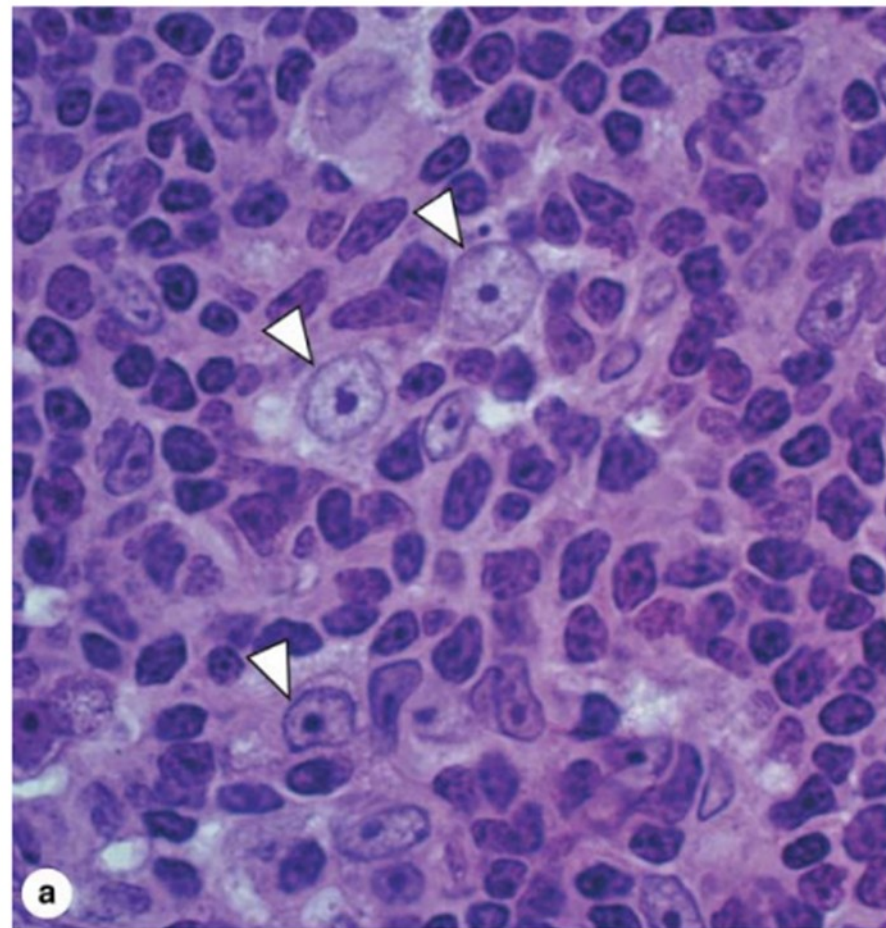
Epithelial Reticular Cells



- **Endodermal in origin**
- **APCs**
- **Form cytotreticulum**
- **Six types**

LM: Stellate, pale **acidophilic** cytoplasm, large ovoid nucleus.

EM: Long processes filled with **tonofilaments** and



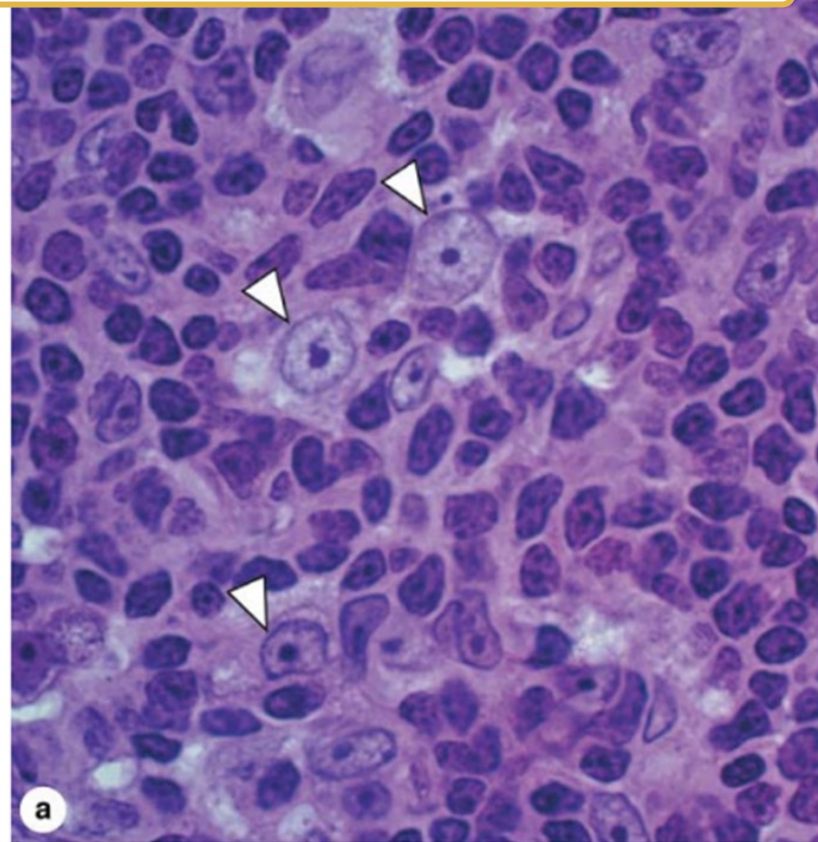
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Epithelial Reticular Cells



■ Function:

- Cytoreticular support
- Synthesize factors and **hormones** for maturation of T-lymphocytes (Thymosin and Thymopoietin H, serum thymic factor).
- Prevent contact



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The thymic cortex is **completely isolated** from all vascular and connective tissue elements by epithelial reticular cells.

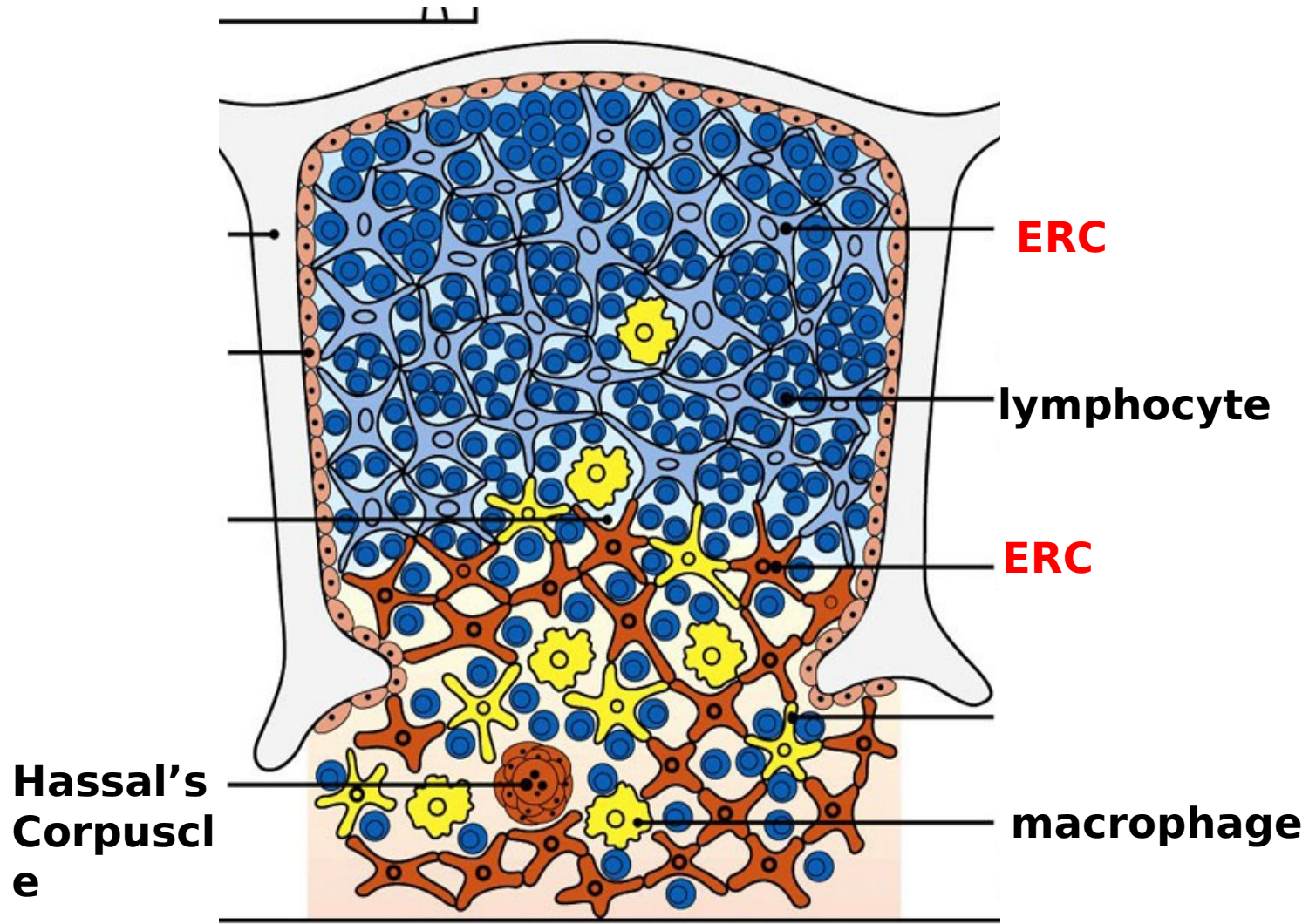
ERC are 3 types in cortex: I, II, III.

Epithelial Reticular Cells

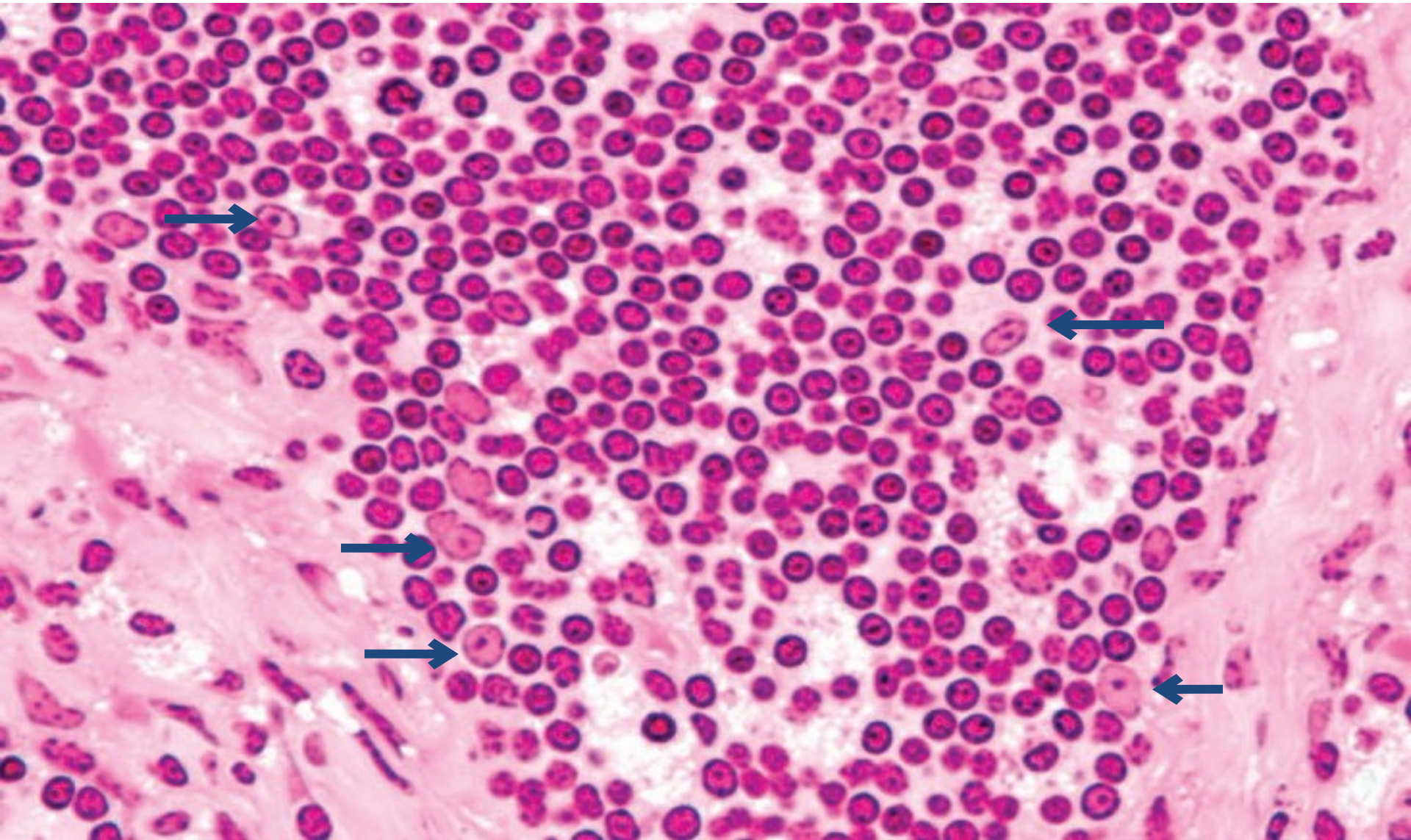
Function

- ❖ **Type I:** forms the blood thymic **barrier** (by **occluding junction**) that isolates the thymic parenchyma from the connective tissue
- ❖ **Type II:**
 - a. have MHCII and is involved in **thymic education**
 - b. form a cytoreticulum support
- ❖ **Type III** form a barrier between the

The Thymus-Epithelial Reticular Cells



Epithelial Reticular Cells



Epithelial Reticular Cells



**-1
Support**

**5-
Protection**

ERCs
are called
Nursing cells
because they
provide
T lymphocytes
with

**-2
Education**

**4-
Growth**

**3-
Nutrition**

Thymocytes

Immature T-lymphocytes, T lymphoblasts



- Derived from the **bone marrow**
- Are immature T-lymphocytes in cortex.
- Surrounded by the processes of the **ERC** separating them from antigens during maturation.
- As they mature, they migrate to inner cortex then towards **medulla**.

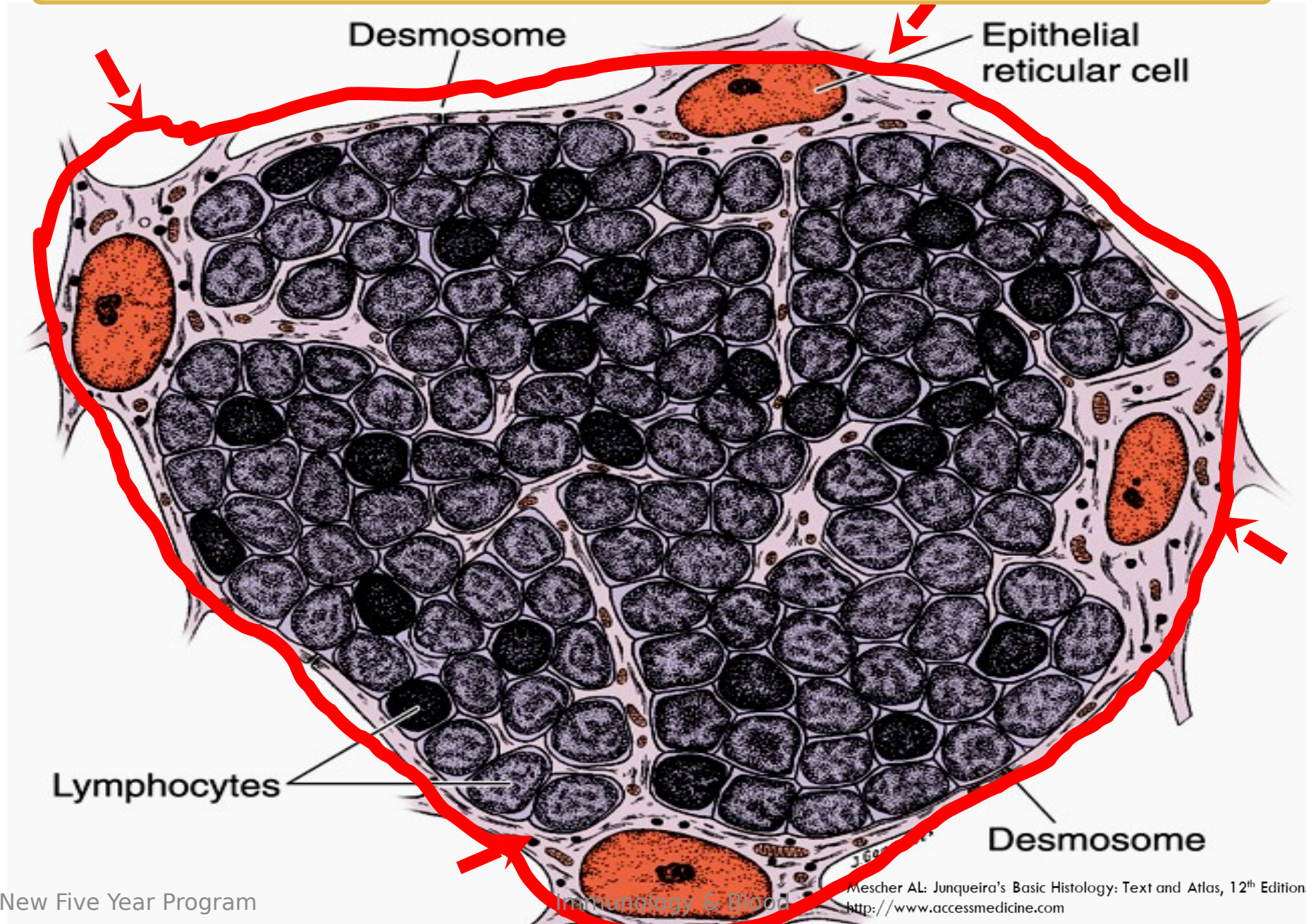
Thymocytes

Immature T-lymphocytes, T lymphoblasts

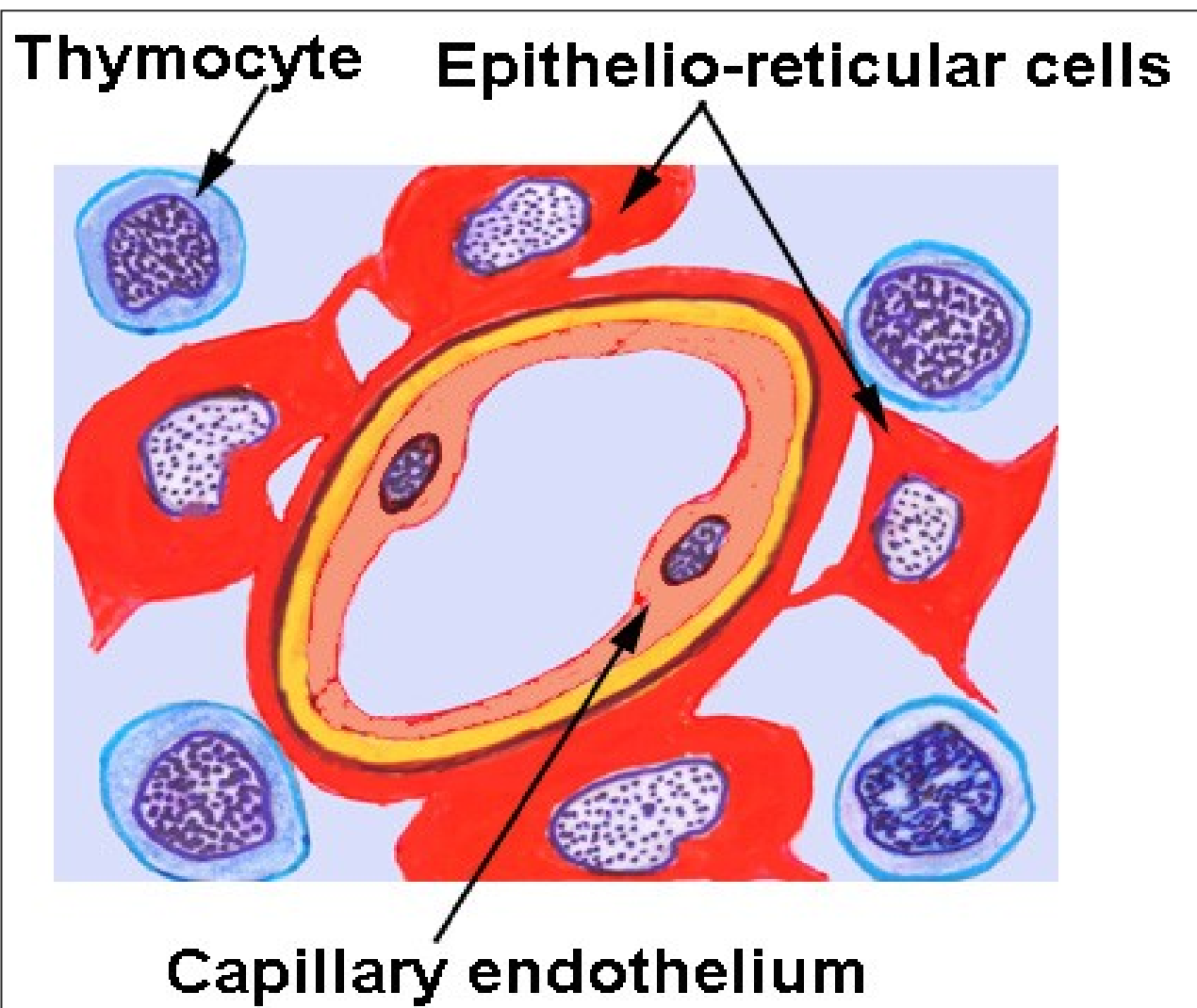


- During maturation, T-lymphocytes express T-cell receptors on the plasma membrane.
- Most T cells die by **apoptosis. Why?**
- If the cells recognize self-proteins as antigens
- The remnants are phagocytosed by macrophages.
- Mature cells migrate to medulla and enter the blood stream through venules at the cortico-medullary

The Cortex of the Thymus



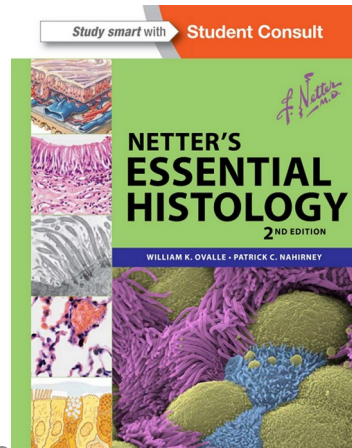
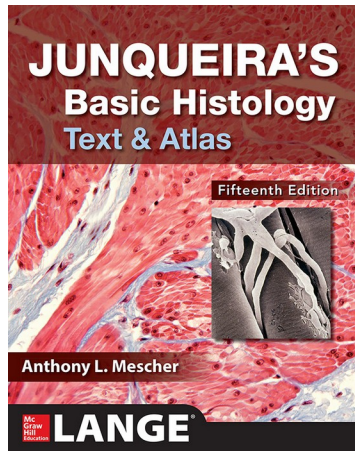
Blood Thymus Barrier



SUGGESTED TEXTBOOKS



1. **Junqueira's Basic Histology: Text and Atlas, 16th Edition by Anthony Mescher, 2018.**
2. **Michael H. Ross & Wojciech Pawlina (2024), Histology Text and Atlas with correlated cell and Molecular Biology, 7th Edition.**



Endocrine & Genitourinary Module

